OPERATING MANUAL
MODEL 3914
NONLINEAR DISTORTION MODULE

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1. GENERAL

1.01 This manual contains information for operating the Model 3914 NONLINEAR DISTORTION plug-in module in conjuction with the Model 3900 COMMUNICATIONS TEST SYSTEM Basic Unit. This section contains a description and specifications for the Model 3914. Figure 1 shows the front panel.

Figure 1. Model 3914 NONLINEAR DISTORTION Module

A. Functional Description

1.02 The Model 3914 measures and displays 2nd and 3rd order nonlinear distortion. Designed to meet Bell System standards per Bell PUB 41009, it measures channel nonlinear distortion using the 4-tone technique* that supersedes harmonic and total distortion measurement methods.

Using tone pairs centered at 860 Hz and 1380 Hz, the module independently measures and displays the inband 2nd and 3rd order nonlinear intermodulation distortion products. In the NORM mode, distortion products from 10 dB to 69 dB below the test signal are displayed directly for test signal levels between +10 dBm and −40 dBm. In the WIDE RANGE mode, distortion products are displayed from −10 dB to −79 dB for input levels ±4 dB from the REL REF preset level. Test signal level is measured by the Basic Unit and is displayed simultaneously with the distortion reading.

B. Specifications

1.03 Specifications for the Model 3914 are contained in Table A.

*HLI Patent No. 3,862,380

TABLE A. MODEL 3914 SPECIFICATIONS

OPERATING MODES	2nd order nonlinear distortion 3rd order nonlinear distortion
NONLINEAR DISTORTION MEASUREMENT	
Input Signal Level Range	+10 dBm to –40 dBm
Input Signal Frequencies	Nominal: 857, 863, 1372 and 1388 Hz
Distortion Frequencies	2nd order: products centered at 520 and 2240 Hz 3rd order: products centered at 1900 Hz
Distortion Measurement Range	–10 dB to –79 dB (wide range) –10 dB to –69 dB (normal)
Resolution	±1 dB
Accuracy	±1 dB to –70 dB, 2nd order ±1 dB to –75 dB, 3rd order
S/N TEST	Shows effects of channel noise or distortion measurements
DIGITAL DISPLAY	2nd order or 3rd order distortion
OVERRANGE INDICATION	Distortion above –10 dB; display flashes
UNDERRANGE INDICATION	
NORM	Distortion below –69 dB; display blanks, – sign on
WIDE RANGE	Distortion below –79 dB; display blanks, – sign on
SELF-TEST	Distortion test generates precise –35 dB, 2nd and 3rd order distortion in local and transmitted signals
SIGNAL GENERATOR (4 TONE)	
Transmitted Signal Frequencies	857, 863, 1373 and 1388 Hz
Frequency Accuracy	±1 Hz
Level Range	+0.0 dBm to –39.9 dBm (set by Basic Unit)
Level Accuracy	±1 dB
Distortion	Harmonic: 35 dB or more below individual tone level
MODULE INTERLOCKS	"Exclusive Measurement" interlock
INDICATORS	INVALID LEVEL (receive) S/N TEST (receive) SPUR (receive) Module ON
MODULE SIZE	Single-width module
MODULE WEIGHT	22 oz. (.624 kg.)
OPTIONS	.01 Deletes upper tone pair instead of lower tone pair during S/N TEST

HLI reserves the right to make changes in specifications at any time without notice.

2. OPERATING INSTRUCTIONS

2.01 This section contains setup procedures for the Model 3914 and related setup procedures for the Basic Unit. Features of the Model 3914 are also described.

A. Setup Procedures

2.02 Set up the Basic Unit to perform a nonlinear distortion measurement as follows:

1) Set POWER switch to in position.
2) Refer to Section 4 of the Basic Unit Operating Manual (3901-M20) for line interface information.
3) Set ABS/REL to ABS.
4) Set REC-LEVEL switch to in position.
5) Set DAMP switch to in position.
6) Set 60 Hz ≷ switch to in position.
7) Set QUIET TERM switch to out position.
8) Set DIAL/TK switch to out position.
9) Set NORM/RETURN LOSS switch to NORM.

2.03 Set up the Model 3914 as follows:

1) Momentarily press ON/OFF switch and observe that the ON/OFF LED is on.

Note: Turning on a conflicting module (e.g., Model 3912 DELAY), or selecting Return Loss mode or setting the REC-LEVEL switch on the Basic Unit to the out position, will automatically turn the Model 3914 off.

2) Observe that the REMOTE GEN indicator on the Basic Unit is on.

2.04 Perform a nonlinear distortion measurement as follows:

1) Set 2ND/3RD switch to desired position.
2) Set NORM/WIDE RANGE switch to the desired position.
3) In the NORM mode, readings to –69 dB will be displayed without requiring additional adjustments.
4) In the WIDE RANGE mode, set the REL REF (DBM) thumbwheel switches on the Basic Unit to obtain a 0 DB NOISE/LEVEL/RETURN LOSS display reading.
5) Read the distortion on the Model 3914 display. Input level variations of ±4 dB may occur without loss of accuracy once Step 4 has been completed.

B. Features

2.05 DIST TEST: Provides an internal check by generating a test signal with known 2nd and 3rd order distortion levels of –35 dB. The signal is both transmitted and internally looped to the receiver whenever the DIST TEST switch is set to in position.

2.06 S/N TEST: Allows user to remove the lower tone pair from the transmitted signal and increase the higher tone pair by 3 dB to test the distortion measurement for effects of channel noise. (Optionally available with deletion of higher tone pair instead of lower tone pair.) Refer to Table B to determine the correction factor required to compensate for the effect of channel noise on the nonlinear distortion measurement.

2.07 NORM Mode: Distortion products to 69 dB below the test signal are displayed for signal levels between +10 dBm and –40 dBm without requiring any level setup adjustments.

2.08 WIDE RANGE Mode: Distortion products to 79 dB below the test signal are displayed for signal levels between +10 dBm and –40 dBm. The REL REF (DBM) thumbwheel switches on the Basic Unit must be set to obtain a 0 DB LEVEL display readout. In this mode, input level variations of up to ±4 dB will not affect accuracy of the measurement.

2.09 INVALID LEVEL Indicator: The LED comes on when the received signal level is greater than +10 dBm or less than –40 dBm in the NORM mode, or when the signal level varies by more than ±4 dB from the REL REF preset level in the WIDE RANGE mode. When

the LED is on, the distortion display will blank with the exception of the negative sign.

2.10 S/N TEST Indicator: The LED comes on when there is at least a 6 dB difference between received signal tone pairs, indicating a twist, or when a S/N test is in process. The S/N TEST LED will be overridden and turned off any time the INVALID LEVEL LED is on.

2.11 SPUR Indicator: The LED comes on when a spurious signal level is equal to or greater than the received 4-tone test signal level.

2.12 Overrange: The display will flash a −10 at a 1 Hz rate when the distortion exceeds −10 dB.

2.13 Underrange: The display will blank with the exception of the negative sign when the distortion goes below −69 dB in NORM mode, or −79 dB in WIDE RANGE mode.

2.14 Frequency Display Blanking: Turning on the Model 3914 automatically blanks the FREQUENCY display on the Basic Unit to eliminate meaningless numbers caused by the 4-tone test signal.

2.15 Freeze: When the FRZ terminal on the rear panel of the Basic Unit mainframe is grounded, the Model 3914 display will hold its reading and any indicators that are on will remain on until the freeze ground is removed, regardless of any changes that occur in the signal or distortion level while the freeze is in effect.

2.16 Lamp Test: When the Model 3914 is on, the Basic Unit LAMP TEST switch (on rear of chassis) will turn on all segments of all displays, including LED indicators, to verify that all of the segments and indicators are functional.

TABLE B. NONLINEAR DISTORTION MEASUREMENT CORRECTION FACTORS

If the S/N test reading is less than the nonlinear distortion reading by one of the values indicated below. . .	. . . add the corresponding correction factor to the nonlinear distortion reading. (See example)
dB	Correction Factor in dB
7	-0.5
6	-0.6
5	-0.8
4	-1.0
3	-1.3
2	-1.7
1	-2.2
0	-3.0
-1	-4.3
-2	-6.9
-3	*
	* Distortion reading is entirely due to noise.

EXAMPLE: If nonlinear distortion reading is -59 dB and the S/N test reading is -62 dB, then the corrected distortion reading would be: -59 dB plus correction factor of -1.3 dB or -60.3 dB which is rounded off to -60 dB.

3. SELF-TEST

3.01 This section contains the procedure for self-testing the Model 3914.

3.02 Set up the Basic Unit as follows:

1) Set POWER switch to in position.
2) Set ABS/REL switch to ABS.
3) Set REC-LEVEL switch to in position.
4) Set 60 Hz ≈ switch to in position.
5) Set DAMP switch to in position.
6) Set QUIET TERM switch to out position.
7) Set DIAL/TK switch to out position.
8) Set BRIDGE/TERM switch to TERM.
9) Set NORM/RETURN LOSS switch to NORM.

3.03 Set up the Model 3914 as follows:

1) Momentarily press ON/OFF switch and observe that the ON/OFF LED is on.
2) Observe that the REMOTE GEN indicator on the Basic Unit is on.

3.04 Perform the self-test procedure as follows:

Note: The following procedural steps refer to the Model 3914 unless otherwise indicated.

1) Set 2ND/3RD switch to 2ND.
2) Hold DIST TEST switch to in position and observe that display readout is −35 DB.
3) Set 2ND/3RD switch to 3RD.
4) Hold DIST TEST switch to in position and observe that display is −35 DB.
5) Connect looping cord from Basic Unit NORM-SEND jack to NORM-REC jack.
6) Set SEND LEVEL (DBM) thumbwheel switches on the Basic Unit to +00.0.
7) Set NORM/WIDE RANGE switch to WIDE RANGE.
8) Set REL REF (DBM) thumbwheel switches on the Basic Unit to +06.0.
9) Observe that INVALID LEVEL indicator comes on and the display blanks with exception of the negative sign.
10) Set REL REF (DBM) thumbwheel switches to −06.0.
11) Observe that INVALID LEVEL indicator comes on and the display blanks with exception of the negative sign.
12) Set REL REF (DBM) thumbwheel switches to 00.0.
13) Observe that INVALID LEVEL indicator goes off and the display blanks with the exception of the negative sign (this indicates low distortion).
14) Observe that NOISE/LEVEL/RETURN LOSS display readout on the Basic Unit is 0.0±1.0 DB.
15) Set 2ND/3RD switch to 2ND.
16) Observe that display blanks with exception of the negative sign (this indicates low distortion).
17) Set NORM/WIDE RANGE switch to NORM.
18) Observe that NOISE/LEVEL/RETURN LOSS display on the Basic Unit is 0.0±1.0 DBM.
19) Observe that display blanks with exception of the negative sign (this indicates low distortion).
20) Set 2ND/3RD switch to 3RD.
21) Observe that display remains blanked with exception of the negative sign (this indicates low distortion).
22) Momentarily press S/N TEST switch and observe that S/N TEST indicator comes on.
23) Set NORM/WIDE RANGE switch to WIDE RANGE.
24) Hold S/N TEST switch to in position, and set REL REF (DBM) thumbwheel switches on the Basic Unit to +06.0.
25) Observe that INVALID LEVEL indicator comes on and the S/N indicator goes out.
26) Set REL REF (DBM) thumbwheel switches to 00.0 and observe that the S/N indicator comes back on and the INVALID LEVEL indicator goes out. This completes the self-test.

4. INSTALLATION/REMOVAL

4.01 This section describes the procedures for installation or removal of the module.

WARNING: Before module installation or removal, make sure that Basic Unit POWER switch is OFF (out position).

4.02 To install the module, proceed as follows:

1) Align the module's PC board with the guides of the Basic Unit slot, and push the module in until the extractor rod contacts the extractor standoff.
2) Turn the extractor screw clockwise while gently pushing the module into the edge connector.
3) Tighten the extractor screw until the module is firmly in place.
4) After the module has been installed, it is recommended that the self-test procedure described in Section 3 be performed to verify that the unit is electrically operational.

4.03 To remove the module, proceed as follows:

1) Turn the extractor screw counter-clockwise until it turns freely.
2) Remove the module by pulling it forward.

WARNING: Handle the module only by top and bottom edges of the PC board.

3) See Paragraph 5.02 for packing and shipping. See Paragraph 5.03 for return to factory.

5. PACKING/SHIPPING, AND RETURN TO FACTORY

5.01 This section contains directions for the packaging and shipment of the module, and special instructions for identification tagging when returning the module to HLI for servicing or repair.

A. Packing and Shipping

WARNING: When the module has been extracted from the Basic Unit, handle the module by the top and bottom edges of the board only. DO NOT handle the rear edge connector. Static electricity may damage the CMOS IC's on the board(s).

5.02 Modules shipped separately from the factory are enclosed in a special conductive envelope that protects the circuitry from static electricity. This protective envelope should be retained and used for reshipment. If the conductive envelope is not available, DO NOT wrap the module in an ordinary plastic bag or plastic sheeting. Instead, proceed as follows:

Note: If the module is being returned for servicing or repair, refer to Paragraph 5.03.

1) If available, cover the entire rear edge connector with conductive shorting bar.
2) Wrap the module in heavy kraft paper.
3) Insert the wrapped module in a strong shipping container. Surround the packaged module with 2 to 4 inches (5 to 10 cm.) thick shock-absorbing material. (Common newspapers may be used.)
4) Mark the container: FRAGILE: DELICATE ELECTRONIC INSTRUMENT

B. Return for Repair or Servicing

5.03 If the module is being returned to HLI for servicing or repair, enclose the following information:

a) Type of service or repair required
b) Model and serial number of the Basic Unit and Expander Unit from which the module was extracted
c) Model and serial number of the module
d) Your return address

Retain a copy of all information for yourself and refer to your copy in any correspondence with HLI.